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##Corso di fisica II

Correzione della prova scritta del I° modulo del 17/12/2008

Esercizio 1

Per definire se i moduli dei campi sono positivi o negativi, fissiamo un SR a coordinate sferiche

centrato nella sfera carica e consideriamo positivo un campo concorde con r

1

, che sia quindi

repulsivo per una carica positiva.

La presenza del piano conduttore con potenziale fissato a 0 fa in modo che il campo elettrico sia nullo alla sua destra.

Per calcolare il campo elettrico e il potenziale nella regione alla sua sinistra, utilizziamo il metodo della carica immagine, ovvero un modello di sistema fisico equivalente in cui non c'è il piano conduttore, ma c'è una carica puntiforme uguale ed opposta a quella della sfera, posizionata simmetricamente rispetto al piano.

Il campo elettrico lungo la retta considerata è quindi:

□

Nulla alla destra del piano

□

Uguale alla somma vettoriale

del campo della sfera positiva e della carica negativa.

Il

modulo del

campo elettrico della sfera E

1

(r), definendo la densità di carica

□

, vale:

0

1

so

A

E

per

0

<

r

< 3R

(regione A)

□

□

3

4

2

4

3
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1
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∞

r
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r
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(regione B)

$\frac{Q}{4\pi\epsilon_0}$
3
4
2
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3
27
125
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∞

r
R
E
C
per $r > 5R$
(regione C)

Il
modulo del
campo elettrico della carica immagine negativa vale:

2
2
2
4
r
Q
E
tot
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∞

, dove
 $\frac{Q}{4\pi\epsilon_0}$

$$\frac{3}{3} \cdot \frac{98}{4} \cdot \frac{1}{1} \cdot \frac{R}{Q_{\text{tot}}}$$

e r

$$2 \cdot \frac{1}{2} \cdot \frac{1}{1} \cdot \frac{R}{Q_{\text{tot}}}$$

è il raggio riferito alla posizione della carica immagine.
In generale abbiamo che

$$r = \frac{R}{2}$$

Considerando solo la retta congiungente i due centri, abbiamo che
(attenzione ai segni dei campi: ricordiamo la definizione di campo positivo)

Nel segmento compreso tra i due centri

$$r = \frac{R}{2}$$

quindi

$$\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{R}{Q_{\text{tot}}}$$

Nella semiretta alla sinistra del centro della sfera

$$r = \frac{R}{2}$$

+ r

$$1$$

e

$\frac{1}{2} \frac{Q}{4\pi\epsilon_0 R^2}$
 $\frac{1}{2}$
 $\frac{2}{30}$
 $\frac{4}{r}$
 R
 Q
 E
 tot
 $\frac{1}{2}$
 $\frac{1}{2}$

[] []
 Quando sommiamo i campi
 E
 $\frac{1}{2}$
 è sempre positivo,
 E
 $\frac{2}{3}$
 è positivo nella regione a destra della sfera.
 A sinistra del centro della sfera
 A destra del centro della sfera
 $0 < r < 3R$
 (regione A)
 E
 tot
 $=E$
 $\frac{1}{2}A$

$\frac{1}{2} \frac{Q}{4\pi\epsilon_0 R^2}$
 $\frac{1}{2}$
 $\frac{1}{30}$
 $\frac{4}{r}$
 R
 Q
 tot
 $\frac{1}{2}$

$\frac{1}{2}$
 $\frac{1}{2}$
 $E_{tot}=E$
 $\frac{1}{2}A$

$\frac{1}{2} \frac{Q}{4\pi\epsilon_0 R^2}$
 $\frac{1}{2}$
 $\frac{1}{30}$
 $\frac{4}{r}$
 R
 Q
 tot

$\frac{1}{2}$
 $\frac{1}{2}$
 R
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 R
 5
 3

\square
 \square
(regione B)

E
tot
=E
1B

$\frac{s}{2}$
 $\frac{s}{2}$
2
1
30
4
r
R
Q
tot

∞

$\frac{s}{2}$
Etot=E
1B

$\frac{s}{2}$
 $\frac{s}{2}$
2
1
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4
r
R
Q
tot

∞

$\frac{s}{2}$
 $\frac{s}{2}$
r > 5R
(regione C)

E
tot
=E
1C

$\frac{s}{2}$
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Con i dati forniti il potenziale totale risulta
(1.81

-

0.25)V = 1.56 V

Esercizio 2

Premesso che l'asta del pendolo deve essere rigida per non piegarsi sotto l'effetto del campo magnetico, le forze agenti nel sistema sono:

\square

La forza di gravità agente sulla massa

\square

La forza

magnetica distribuita sull'intera lunghezza del filo / dell'asta.

Vi sono poi i vincoli del sistema, che possono essere espressi da:

\square

La reazione vincolare del fulcro del pendolo alle forze agenti.

Per quanto riguarda la forza peso, sappiamo che può essere scomposta

\square

in una componente parallela al filo

\square

\cos

mg

F

T

$\sqrt{0}$

, dove T sta per la tensione del filo

dovuta alla sola forza peso (e non ad effetti centrifughi legati al moto)

e

che non ha effetti

sul moto.

\square

in una componente perpendicolare e diretta verso il centro

\square

\sin

mg

F

R

$\sqrt{0^{\infty}}$

, dove R sta per

richiamo ed è la componente che si considera nel moto del pendolo.

La forza magnetica è indipendente dall'angolo nella configurazione che consideriamo, dal

momento che questo giace in un piano perpendicolare al campo magnetico. Inoltre

è sempre diretta
nello stesso verso, visto che questo dipende esclusivamente dal verso di
percorrenza della corrente
e dal campo magnetico, ed entrambi sono costanti.
Dal momento che la densità di corrente e il campo sono perpendicolari, l' espressione per la forza è:

IBL

F

M

Queste sono le forze agenti. Se vogliamo considerare anche le reazioni vincolari
(non richieste)
teniamo presente che il pendolo non può traslare, quindi la somma delle forze
deve essere zero

lungo ogni componente. Queste forze sono da considerarsi sul perno del pendolo.

Lungo la componente parallela al filo, c'è la " resistenza " del perno alla
tensione, che è
quindi uguale e contraria a

T

F

In direzione perpendicolare al filo bisogna porre

0

0

M

R

V

F

F

F

Per verificare la condizione di equilibrio è a questo punto evidente che si deve
lavorare sui

momenti torcenti e non sulle forze (la

cui somma è zero su ogni componente).

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C al f |ln#YR| %#. ,#####,#####Scegliamo di
considerare i momenti sulla massa (equivalente sarebbe stato sceglierli in
qualsiasi

altro punto, ma qui il significato fisico è più evidente).

Nello schema proposto la corrente gira in verso orario, verso l'alto nel
pendolo.

Il campo

magnetico è uscente dal foglio.

La forza magnetica è perpendicolare al filo e rivolta verso destra,
quindi la posizione di equilibrio del pendolo è a destra. Per trovare il momento
esercitato dalla

forza magnetica possiamo o

considerarla agente nel centro del filo (ATTENZIONE: non nel

baricentro, non ha nulla a che vedere con le proprietà di massa del sistema) o
effettuare l'integrale.

Per il modulo del momento:

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Nota sulle reazioni vincolari: avendo scelto di valutare i momenti rispetto al
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le reazioni vincolari hanno momento nullo.

Per trovare il punto

di equilibrio dobbiamo solo pareggiare i moduli dei momenti (abbiamo già
individuato il semipiano in cui si trova il punto).

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Con i valori forniti nel testo

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A cura di Paolo A.C.

pac.n@hotmail.it

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